Stable isotope and trace elements as New Zealand geo-location markers for biosecurity

Holder, P., Armstrong, K., Clough, T., Frew, R. and Kumarasinghe, L.

Peter Holder:
holderp@lincoln.ac.nz
Lincoln University, Canterbury, New Zealand

K. Armstrong:
armstron@lincoln.ac.nz
Lincoln University, Canterbury, New Zealand

T. Clough:
clought@lincoln.ac.nz
Lincoln University, Canterbury, New Zealand

R. Frew:
rfrew@otago.ac.nz
University of Otago, Dunedin, New Zealand

L. Kumarasinghe:
kumarasinghel@maf.govt.nz
Ministry of Agriculture and Forestry, Tamaki, New Zealand

A collaborative PhD programme aims to assess the value of stable isotope and trace element analysis for determining the origin of high impact exotic insect pests that threaten New Zealand's biosecurity.

Introduction

Knowledge of whether an exotic pest specimen collected 'post border' is a new arrival, or part of a hitherto undetected established population, enables effective biosecurity action, potentially saving millions of dollars used for emergency response surveillance[1] for a pest that might not have established (Figure 1).

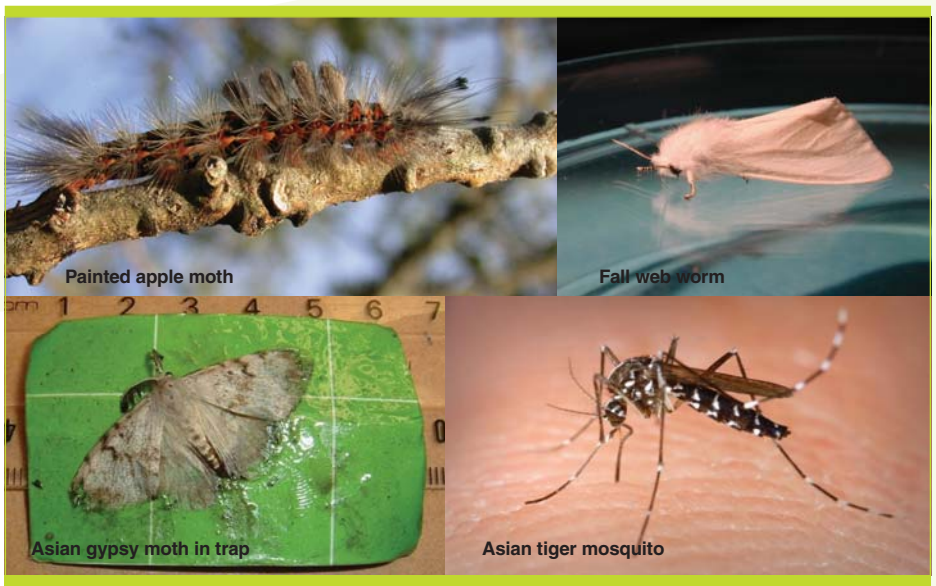

Figure 1 Stable isotope analysis was engaged to determine whether the 'new' finds of painted apple moth and fall web-worm in Auckland in 2005 were new incursions, or indications of treatment failure in the 1999-2004 eradication campaigns. Only tentative conclusions were possible as the application of this technology in such cases has yet to be critically examined Other biosecurity responses where point of origin discrimination would have had high operational value have been detections of Asian gypsy moth in Hamilton, 2003, response cost $12.4M; and Asian tiger mosquito in Auckland, 2007, response cost approximately $500,000.

Rationale

Stable isotope technology is being considered as a key biosecurity tool to distinguish the geographic origins of invasive exotic insects in New Zealand. Stable isotope and trace element signatures have been used to trace the origin of a wide range of non-biological and biological materials[2, 3, 4]. However, the value of this technology is unproven for accidentally introduced and potentially polyphagous taxa. Fundamental research, on how geo-location signatures are reflected in such insects is needed[5].

Aim

To test the feasibility of using multi stable isotope and trace element analysis for New Zealand geo-location discrimination in a biosecurity context.

An integrated research programme

Recent research in New Zealand, with light brown apple moth (LBAM) as a model insect, demonstrated good water-plant-insect δ^2H geo-location expression in lab populations[6] consistent with similar studies[2, 7]. However, the δ^2H, $\delta^{18}O$ and $\delta^{13}C$ values of wild LBAM populations were found to be too variable to provide geo-location discrimination by any single isotope signature (Figure 2)[8].

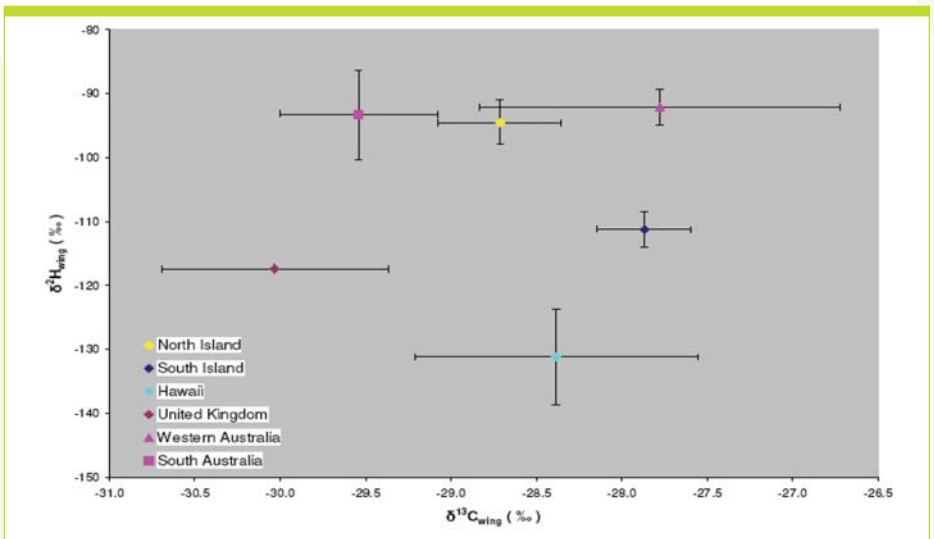

Figure 2 Average carbon-13 and deuterium values (with SD bars) of light brown apple moth, displayed by region (New Zealand (North Island, South Island), Australia, Hawaii and United Kingdom). (From Husheer and Frew 2006b). Variation was too high for geo-location discrimination by any single isotope signature.

A national isotope map of New Zealand precipitation is currently under development, under a Cross Department Research Programme (MAF BNZ + Department of Conservation + University of Otago).

This PhD will build on the existing geo-location research, above, and be integrated as much as possible with ongoing aligned research in New Zealand, including planned food provenance research

Objectives and methods

Complementary field and laboratory controlled environment studies will use model soil-plant-insect systems to

- confirm the biological representation of stable isotope and trace element signatures in plant and insect tissues as geo-location markers,
- identify the elements that have potential to contribute to a New Zealand point of origin signature (Figure 3),
- examine the constraints of small sample mass and restricted sample sizes,
- explore the influence of varying dietary and climatic histories.

This work will contribute to or enable a New Zealand point-of-origin classification model. This model will be applicable to other systems and disciplines.

Figure 3 Soil from high risk locations will be used in controlled environment studies, to identify the elements that have potential to contribute to a New Zealand point of origin signature. Complementary field soil-plant-insect studies will be used to measure the real-world expression of stable isotope and trace element signatures in plant and insect tissues as geo-location markers.

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Acknowledgments

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Images courtesy of: Asian gypsy moth University of Georgia, Figure 1 MAF BNZ, Scion Research, Public Health Image Library US CDC; Figure 2 Husheer and Frew (2006b); Figure 3 Stuart Larsen, Lincoln University.

PO Box 84,
Lincoln University,
Canterbury,
New Zealand
Phone:
+64 3 325 3696
Fax:
+64 3 325 3864

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